JOINT INVENTORS

APPLICATION FOR UNITED STATES LETTERS PATENT

S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN:

Be it known that we, Lothar Werzinger a citizen of Germany, residing at Am Judenfeld 3, 93059 Regensburg, Germany, and Stefan Piana a citizen of Germany, residing at Dendorfer Strasse 9a, 93096 Köfering, Germany, have invented a new and useful PROCESS AND DEVICE FOR INSPECTING TRANSPARENT CONTAINERS, of which the following is a specification.

Process and Device for Inspecting Transparent Containers.

~~Description~~

The invention relates to a process in accordance with the introductory portion of patent claim 1 and a device in accordance with the introductory portion of patent claim 4.

In the inspection of transparent containers, particularly beverage bottles, two camera systems and at least two illumination systems, if applicable, are, as a general rule, used in order to carry out the evaluation of the container wall (inspecting of the side wall) and the evaluation of the container contour, because an illumination other than the one used for the evaluation of the wall is necessary for the evaluation of the contour. The inspection device is thus made more expensive by the two camera systems. In addition, the expense for maintenance is high (DE 19 904 732 A).

In the German patent document DE 19 904 732 A, it is proposed to use a single CCD camera for the two exposures, to use a maximum intensity of illumination for the exposure of the wall of the container, and to reduce the intensity of illumination for the exposure of the contour of the same container.

The task which forms the basis of the invention is that of devising a process of the type stated above, as well as a device that is suitable for carrying out the process, by means of which a reliable evaluation of the wall and evaluation of the contour are possible in another way by means of one single CCD camera.

The task that has been set is solved, in accordance with the process, by means of the characteristic feature of claim 1 and, in accordance with the device, by means of the characteristic feature of claim 4.

Both the optimally exposed image of the wall, as well as the optimally exposed image of the contour, can be produced by changing the sensitivity of exposure of the single CCD camera. The sensitivity of exposure is, as a variable process parameter, important precisely in regard to the presuppositions which are decisive for the quality of both of the exposures precisely at the point where the images ultimately arise -- that is to say, in the CCD camera. In this way, optimally exposed images of the contour and of the wall are formed, from which a high reliability of evaluation results. It is obvious that the container that is inspected during the inspection can, if necessary, be rotated in order to obtain, with several first and second exposures, a comprehensively complete image of the wall of the container or of the course of contour of the container. A container can, however, also be depicted over its full circumference by means of only a single first and second exposure if optical devices, such as mirror apparatuses or the like, are used, which devices simultaneously produce several images of the container, exposed in a

circumferentially-shifted manner, in only a single camera image. Suitable mirror apparatuses, such as in WO 95/04267, for example, are already known.

The device manages to work with a single CCD camera, the sensitivity of exposure of which is modified in such a manner that the image of the wall and the image of the contour are exposed in an optimal manner. Even the smallest damages to or contaminations of the wall, or deviations in the contour, can also be determined with only a minimal expense for equipment. In addition, the device is maintenance-friendly, because few components that require maintenance are present.

The specific first and second exposures are formed, in a manner that is simple in terms of technical process, at the same intensity of illumination. The illumination can take place, in a preferred manner, by means of flashes, such as by means of an LED luminous screen, for example. An expensive, controllable illumination device, with zones of brightness which can be adjusted in different manners, is not necessary.

The exposures of a container taking place in a time-staggered manner are stored in memory, whereby the evaluation (contour, wall) can be carried out later, in either a temporally parallel or a sequential manner.

In accordance with the device, a control device is used, which device changes the sensitivity of exposure of the CCD camera by changing the exposure time in an optimized or in an alternating manner, as the case might be. This can be brought about, in several trigger positions, by means of an electronic control circuit.

The source of illumination is, in a suitable manner, at least one LED radiant field which can, in a preferable manner, be activated in individual flashes. In this manner, the images can be produced with great sharpness and at a uniform exposure.

The source of illumination of the CCD camera can either be positioned on opposite sides of the path of movement of the container (examination of transmitted light), or else on the same side (examination of incident light).

One form of implementation of the object of the invention is illustrated by means of the diagrams. These depict the following:

Fig. 1: In schematic terms, a cross-section through a device for inspecting transparent containers;

Fig. 2: A schematic view from above of Fig. 1;

Fig. 3: In schematic form, an exposure of the wall; and

Fig. 4: In schematic form, an exposure of the contour of the container.

In a device (V) for inspecting transparent containers (B), such as beverage bottles of glass or of plastic (PET), for example, each container (B) in a series of containers being continuously moved forward is inspected, during its passage through the device, in regard to the quality of its container wall (W), as well as the contour (P) of the same. Containers with contaminations and/or damages and/or impermissible deviations in their contour should be detected and subsequently separated out. Each container (B) is transported through an inspection area on a conveying device (F). The conveying device (F) has two conveyor belts (1, 2), for example, which are driven in the same direction but at different speeds, in order to simultaneously rotate the container (B) around its vertical axis during the transport movement. A source of illumination (L), such as at least one LED radiant field (3), for example, which source can be activated to individual flashes by means of an electronic control device (C1), is positioned on one side of the conveying device (F). For example, a single CCD camera (K) is positioned on the opposite side and oriented towards the inspection area in which the exposures of the container are formed and, in specific terms, two different exposures are made, namely, an exposure of the wall and an exposure of the contour, each in an alternating manner. An electronic control device (C2) is provided for the CCD camera.

An evaluation device (A) connected with the single CCD camera (K), in which device the images of the wall and the images of the contour are evaluated, can additionally be seen in the schematic view from above of Fig. 2. Upon the determination of a contamination and/or damage and/or a deviation in contour, a separating device (S) is activated, which device conveys the container (B) in question into a given area (4) (collecting bin, or the like).

A sensor (5), which can, for the clocking of the source of illumination (L) of the CCD camera (K), be connected with the control devices (C1, C2), is provided at the start of the inspection area. The control devices can additionally be connected with a rotational pacesetter of the drive unit (6) of the conveying device (F) in order to follow the container (B) in the inspection area in a manner dependent upon the conveying speed. This is suitable, for example, if several exposures of one container are to be carried out in different rotational positions. Trigger positions of a hardware type or of a software type (T1, T2) are taken into consideration during the inspection in order, for example, to change the sensitivity of exposure of the CCD camera (K), by means of the control device (C2), between the first and the sequentially-following second exposures in an alternating manner, in such a way that, in one exposure of the wall (first exposure), a different sensitivity of exposure is set than in another exposure of the contour (second exposure). In this, it is suitable to consider several trigger positions, such as in a multiple exposure of a container, for example.

In Fig. 3, an exposure of the wall of the container (B) is depicted schematically, in which, by adjusting the sensitivity of exposure -- that is to say, the exposure time -- of the CCD camera (K), an optimal exposure is provided for detecting contaminations and/or damages (X) either on or in the wall (W) of the transilluminated container, as the case may be. In actual practice, the image of the exposure of the wall is not optimal for the determination of the contour of the container. Normally, an illumination that is suitable for the exposure of the wall provides an image from which the outline of the container can only be detected with difficulty, which image is too bright for inspecting the contour.

In the exposure of the contour in Fig. 4, on the other hand, the contour (P) of the container (B) is imaged in a sharp and meaningful manner, as represented by the solid outline, in order to detect deviations (Y) in the contour. In the exposure of the contour, the wall itself is not imaged in a manner which is sufficiently detailed for the detection of flakes of dirt, etc. An exposure which is sufficient for inspecting the contour is, as a general rule, too dark for inspecting the wall.

If necessary, not only is the sensitivity of exposure of the CCD camera modified in such a manner that the exposures of the wall are exposed in an optimal manner for the exposures of the contour, but the intensity of illumination is also strongly modified for the equalization of different levels of transparency of the container through the fact, among other points, that the flash time of the LED radiant field (3) is modified by means of the control device (C1), for example.

The sensitivity of the exposure or the exposure time for the container (B) which is optimal for the specific exposure of the wall or the exposure of the contour, respectively, is set in advance. During the inspection, the sensitivity of exposure is then adjusted back and forth between the values set in an alternating manner. By this means, it is thereby possible to scan the specific level of transparency of the container which is to be inspected, and to then set the specifically optimal trigger position (T1 or T2) or the sensitivity of exposure corresponding to this trigger position, as the case may be. In a similar manner, the flash time for the exposure of the wall or for the exposure of the contour, as the case may be, can be adjusted in an individual manner.